Fermilab

Directorate

MEMORANDUM OF UNDERSTANDING
FOR THE 2013 FERMILAB TEST BEAM FACILITY PROGRAM

T-XXXX

Performance Evaluation of a RICH-Prototype Based on CsI-GEMs

February 02, 2013

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I. INTRODUCTION

This is a memorandum of understanding (MOU) between the Fermi National Accelerator Laboratory (Fermilab) and the experimenters of Stony Brook University who have committed to participate in beam tests to be carried out during the 2013 Fermilab Test Beam Facility program.

The memorandum is intended primarily for the purpose of recording expectations for budget estimates and work allocations for Fermilab, the funding agencies and the participating institutions. It reflects an arrangement that currently is satisfactory to the parties; however, it is recognized and anticipated that changing circumstances of the evolving research program will necessitate revisions. The parties agree to modify this memorandum to reflect such required adjustments. Actual contractual obligations will be set forth in separate documents.

This MOU fulfills Article 1 (facilities and scope of work) of the User Agreements signed (or still to be signed) by an authorized representative of each institution collaborating on this experiment.

Description of Detector and Tests:

The aim of this test is to verify the performance of a Ring-Imaging-Cherenkov (RICH) detector based on Gas-Electron-Multiplier (GEM) detectors and CF4 as the counting gas. This technology is foreseen to become part of the Particle Identification (PID) system of an EIC-detector.
The detector consists of a stainless steel tube which is closed at one end with a mirror and at the other end with the GEM-detector in the focal plane of that mirror. The readout plane for a quintuple-GEM detector can be interchanged between two-dimensional strip and single pads readout. The primary goal of the tests is to prove that the ring diameter obtained with both readout-plane structures will suffice particle discrimination up to high momenta. For this it is to show that the measured width of a ring from an electron traversing the Cherenkov tube can be obtained up to a desired precision. This requires the measurement of the ring with a high number of photo-electrons which will be ascertained by the counting gas and the special treatment of the mirror so that it allows the reflection of VUV-photons with high efficiency. Also, charge sharing on the separate strip-layers will require a rather large gain which can be only accomplished by the introduction of five GEM layers rather than the standard triple-GEM amplification structure. On the other hand, this quintuple-GEM structure might challenge the "blindness" to tracks since it provides a detection system within the four layers after the photo-sensitive layer and the latter will be operated in reverse bias mode.

<u>Experimental Apparatus</u>

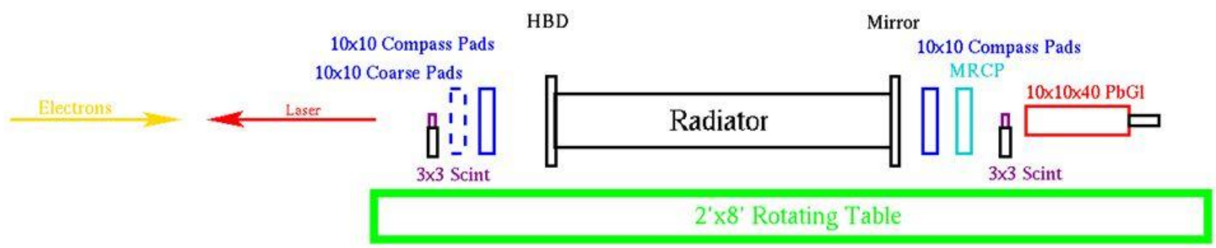


Figure 1 Cross-section (not to scale) of the proposed setup for the test in beam of the RICH prototype.

The experimental setup with overall dimensions is shown in Figure 1. It consists of a 1 meter long, 20 cm radius, cylindrical tank made out of stainless steel. This tank will be equipped with a mirror to reflect the Cherenkov light on the GEM+CsI module placed on the side detector arm. Along with the detector, a trigger system provides timing information and electron identification. This trigger system consists of two scintillator pads (one on the front and one on the back) and a compact electromagnetic calorimeter.

The setup (detector+trigger) will be placed in a 4 × 8 feet aluminum box. The setup will have an additional high precision tracking hodoscope, sandwiching the RICH detector. The additional detectors would be four planes, 10 x 10 cm^2 each, of triple-GEM detectors with X-Y readout, 256 channels for each coordinate.

The data acquisition will consist of a Scalable Readout System (SRS) system equipped with front-end hybrids and Analogue Pipeline Voltage mode with 2.5V operating voltage integrated circuits (APV25). The SRS system has been developed within the RD51 collaboration and all detectors will have a connection to this system. The DAQ will be controlled with a standard PC and dedicated software. Additional components will be needed for remotely monitoring the trigger and readout system. Components needed are patch panels and connection lines into the test-beam area.

The HV supplies for the detectors will be provided by a LeCroy 1450 mainframe with modules providing HV supply for all gas detectors as well as for photo-multipliers for the trigger scintillators. The HV supply will be placed in the vicinity of the detector setup. A digital oscilloscope will be used for adjusting and monitoring the various detector components electronics. This oscilloscope will be provided by the SBU group.

The main detector (GEM-RICH) as well as the GEM tracking detectors are gaseous detectors and will need a gas supply and will be provided by the SBU group. The gas system is based upon a pump-circulating gas loop with gas purification units in order to recycle the rather expensive counting gas CF_4 for the ˇCerenkov detector. A custom-build gas-rack will be used which will also provide the counting gas (CO_2) for the GEM tracking detectors. This gas will be exhausted. For the gas system one needs to place gas cylinders filled with appropriate gases close to detectors so that gas supply lines can be minimized.

The data will be readout with above mentioned DAQ system and sent to regular PCs. These PCs will be placed in the vicinity of the detectors and will be remotely controlled. We will need Ethernet access to communicate with the electronics and saving data on disk. We will provide uninterrupted power supplies (UPS) that can be remotely controlled so that in case of any unwanted power loss or unresponsive hardware the system can be rebooted.

The detector setup will be placed on a table that can be tilted in a vertical plane with a motor system. The motor can be controlled remotely. The overall detector setup will be assembled and tested at the Stony Brook University and after the final tests disconnected from all stationary electric and gas lines. The setup will be transported in that state to the test-beam area with a truck. The truck has to be unloaded with a fork-lift as close as possible to the final position in the test-beam area. The table on which the detector setup is placed is provided with wheels so that it can be moved into the final position and locked.

II. PERSONNEL AND INSTITUTIONS:

Spokesperson:

Co-spokespersons and physicists in charge of beam tests: Thomas Hemmick, Klaus Dehmelt

Fermilab liaison: Aria Soha

The group members at present are: *(Please use full names)*

	Institution	Country	Collaborator	Rank/Position	Other Commitments
1.1	Stony Brook University	USA	Klaus Dehmelt	Reasearch Scientist	PHENIX
			Nils Feege	Postdoc	PHENIX
			Hujin Ge	Graduate student	PHENIX
			Thomas Hemmick	Professor	PHENIX
			Serpil Yalçin	Graduate student	PHENIX
			Stephanie Zajac	Graduate student	

III. Experimental Area, Beams and Schedule Considerations:

3.1 Location

3.1.1 The beam test(s) will take place in MT6.2A. The test beam setup is mounted on an 8' x 4' table and would need to be mounted on a table which can be adjusted with respect to the beam height. Additional space around the table would be needed for HV- and gas-supply (see Figure 2). If the gas supply would need to be outside the test beam area we would need additional space for the gas-rack.

3.1.2 Space for two 19" racks is needed outside the test beam area (in the electronics room?). Storage space is needed for transport equipment during the test beam. Space for computers would be needed in the control room.

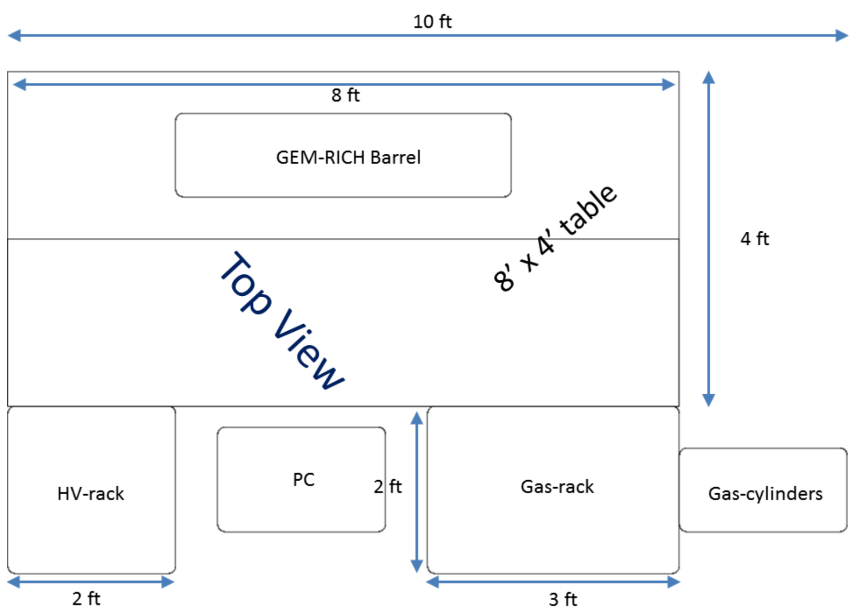


Figure 2 Overall sketch of the proposed setup for the test in beam of the RICH prototype with space requirements.

3.2 Beam

3.2.1 Beam Types and Intensities

Energy of beam: 10, 16, 20 GeV
Particles: kaons
Intensity: <1k particles/ 4 sec spill
Beam spot size: about 0.25 cm^2

Energy of beam: 4, 8, 16 GeV
Particles: pions
Intensity: <1k particles/ 4 sec spill
Beam spot size: about 0.25 cm^2

Energy of beam: 2, 4, 6 GeV
Particles: electrons
Intensity: <1k particles/ 4 sec spill
Beam spot size: about 0.25 cm^2

3.2.2 Beam Sharing

We could share the beam unless path or momentum of particles is significantly changed.

3.2.3 Running Time

[This is for describing any special or specific needs, such as frequent accesses, or non-typical run hours or access conditions. If you expect to take beam between the hours of 1000 – 2200, and should not need to access the apparatus under controlled access conditions regularly, you do NOT need to include this section.] See section 2.3.3 for total run time.

3.3 Experimental Conditions

3.3.1 Area Infrastructure

[Describe your setup, include weights and dimensions. Include any facility infrastructure the experiment needs, like motion tables, Ethernet connections, tracking or trigger systems, etc.]

3.3.2 Electronics Needs

[Particularly describe any non-commercial electronics, in depth. Please note, electrical diagrams of any non-commercial electronics will need to be submitted two weeks prior to the ORC review.]

[See Appendix II for summary of PREP equipment pool needs. Or No PREP electronics are requested.]

3.3.3 Description of Tests

[A General Run Plan: Describe the day to day activities of conducting the experiment, and any special needs the experiment might have. When would you change detectors? beam types? etc.]

3.4 SCHEDULE

[*Specify how often and for what length of time you would make beam requests* (ie. The experiment requests two weeks, with a return date to be specified later, for two more weeks), *as well as when you expect you experiment to be complete.* (ie. The experiment will return to continue tests until 2015, *or* until SLHC begins commissioning, etc.)]

IV. RESPONSIBILITIES BY INSTITUTION – NON FERMILAB

4.1 NAME OF INSTITUTION:

- (*List or describe contributions to the experiment by this institution.*)

[*Replacement cost of existing hardware*]

V. RESPONSIBILITIES BY INSTITUTION – FERMILAB

5.1 FERMILAB ACCELERATOR DIVISION:

4.1.1 Use of MTest beamline as outlined in Section II.

4.1.2 Maintenance of all existing standard beam line elements (SWICs, loss monitors, etc) instrumentation, controls, clock distribution, and power supplies.

4.1.3 Scalers and beam counter signals should be made available in the MTest control room.

4.1.4 Reasonable access to the equipment in the MTest beamline.

4.1.5 Connection to beams console and remote logging (ACNET) should be made available.

4.1.6 The test beam energy and beam line elements will be under the control of the AD Operations Department Main Control Room (MCR). [0.5 person-weeks]

4.1.7 Position and focus of the beam on the experimental devices under test will be under control of MCR. Control of secondary devices that provide these functions may be delegated to the experimenters as long as it does not violate the Shielding Assessment or provide potential for significant equipment damage.

4.1.8 The integrated effect of running this and other SY120 beams will not reduce the neutrino flux by more than an amount set by the office of Program Planning, with the details of scheduling to be worked out between the experimenters and the Office of Program Planning.

5.2 FERMILAB PARTICLE PHYSICS DIVISION:

4.2.1 The test-beam efforts in this MOU will make use of the Fermilab Test Beam Facility. Requirements for the beam and user facilities are given in Section II. The Fermilab Particle Physics Division will be responsible for coordinating overall activities in the MTest beam-line, including use of the user beam-line controls, readout of the beam-line detectors, and FTBF computers. [1.0 person weeks]

4.2.2 [If needed: Set up and maintenance of [specify] tracking system.]

4.2.3 Conduct a NEPA review of the experiment.

4.2.4 Provide day-to-day ESH&Q support/oversight/review of work and documents as necessary.

4.2.5 Provide safety training as necessary, with assistance from the ESH&Q Section.

4.2.6 Update/create ITNA's for users on the experiment.

4.2.7 Initiate the ESH&Q Operational Readiness Clearance Review and any other required safety reviews. [0.2 person-weeks]

5.3 FERMILAB SCIENTIFIC COMPUTING DIVISION

4.3.1 Internet access should be continuously available in the MTest control room.

4.3.2 See Appendix II for summary of PREP equipment pool needs.

5.4 FERMILAB ESH&Q SECTION

4.4.1 Assistance with safety reviews.

4.4.2 [Loan of radioactive source (specify sources) for (specify duration).]

4.4.3 Provide safety training, with assistance from PPD, as necessary for experimenters. [0.2 person weeks]

VI. Summary of Costs

Source of Funds [$K]	**Materials & Services**	**Labor** (person-weeks)
Particle Physics Division	0.0	1.0
Accelerator Division	0	0.5
Scientific Computing Division	0	0
ESH&Q Section	0	0.2
Totals Fermilab	$0.0K	1.7
Totals Non-Fermilab	[specify from Section III]	[specify]

VII. General Considerations

6.1 The responsibilities of the Spokesperson and the procedures to be followed by experimenters are found in the Fermilab publication "Procedures for Researchers": (http://www.fnal.gov/directorate/PFX/PFX.pdf). The Spokesperson agrees to those responsibilities and to ensure that the experimenters all follow the described procedures.

6.2 To carry out the experiment a number of Environmental, Safety and Health (ESH&Q) reviews are necessary. This includes creating an Operational Readiness Clearance document in conjunction with the standing Particle Physics Division committee. The Spokesperson will follow those procedures in a timely manner, as well as any other requirements put forth by the Division's Safety Officer.

6.3 The Spokesperson will ensure at least one person is present at the Fermilab Test Beam Facility whenever beam is delivered and that this person is knowledgeable about the experiment's hazards.

6.4 All regulations concerning radioactive sources will be followed. No radioactive sources will be carried onto the site or moved without the approval of the Fermilab ESH&Q section.

6.5 All items in the Fermilab Policy on Computing will be followed by the experimenters. (http://computing.fnal.gov/cd/policy/cpolicy.pdf).

6.6 The Spokesperson will undertake to ensure that no PREP or computing equipment be transferred from the experiment to another use except with the approval of and through the mechanism provided by the Scientific Computing Division management. The Spokesperson also undertakes to ensure no modifications of PREP equipment take place without the knowledge and written consent of the Computing Sector management.

6.7 The experimenters will be responsible for maintaining both the electronics and the computing hardware supplied by them for the experiment. Fermilab will be responsible for repair and maintenance of the Fermilab-supplied electronics listed in Appendix II. Any items for which the experiment requests that Fermilab performs maintenance and repair should appear explicitly in this agreement.

At the completion of the experiment:

6.8 The Spokesperson is responsible for the return of all PREP equipment, computing equipment and non-PREP data acquisition electronics. If the return is not completed after a period of one year after the end of running the Spokesperson will be required to furnish, in writing, an explanation for any non-return.

6.9 The experimenters agree to remove their experimental equipment as the Laboratory requests them to. They agree to remove it expeditiously and in compliance with all ESH&Q requirements, including those related to transportation. All the expenses and personnel for the removal will be borne by the experimenters unless removal requires facilities and personnel not able to be supplied by them, such a rigging, crane operation, etc.

6.10 The experimenters will assist Fermilab with the disposition of any articles left in the offices they occupied.

6.11 An experimenter will be available to report on the test beam effort at a Fermilab All Experimenters' Meeting.

SIGNATURES:

____ / / 2013
Thomas K. Hemmick, Experiment Spokesperson

____ / / 2013
Michael Lindgren, Particle Physics Division, Fermilab

____ / / 2013
Roger Dixon, Accelerator Division, Fermilab

____ / / 2013
Robert Roser, Scientific Computing Division, Fermilab

____ / / 2013
Nancy Grossman, ESH&Q Section, Fermilab

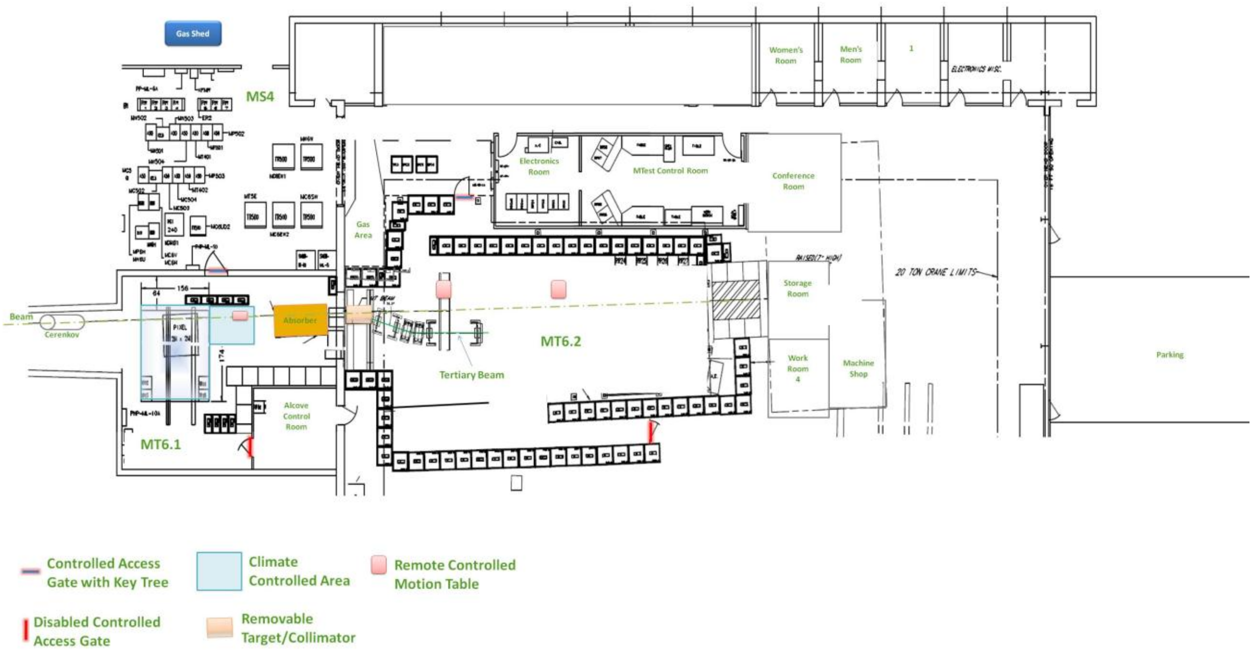
____ / /2013
Greg Bock, Associate Director for Research, Fermilab

____ / /2013
Stuart Henderson, Associate Director for Accelerators, Fermilab

APPENDIX I: MT6 AREA LAYOUT

[Describe where you would like to put your apparatus, or how you would like to arrange it. Including a diagram is a good idea. You may draw on the picture below, or use the power-point file on the website to create your own. See examples for ideas.]

MTEST AREAS



Appendix II: Equipment Needs

Provided by experimenters:

[If you wish you may include a breakdown of what is being provided by which institution, for your records.]

Equipment Pool and PPD items needed for Fermilab test beam, on the first day of setup.

PREP Equipment Pool:

Quantity	Description
X	Type of item
X	Type of Item

PPD FTBF:

Quantity	Description
X	Type of item
X	Type of Item

APPENDIX III: - HAZARD IDENTIFICATION CHECKLIST

Items for which there is anticipated need *should be* checked. See next page for detailed descriptions of categories. *(There is NO need to list existing Facility infrastructure you might be using)*

Flammable Gases or Liquids		**Other Gas Emissions**		**Hazardous Chemicals**		**Other Hazardous /Toxic Materials**
Type:		Type:			Cyanide plating materials	List hazardous/toxic materials planned for use in a beam line or an experimental enclosure:
Flow rate:		Flow rate:			Hydrofluoric Acid	
Capacity:		Capacity:			Methane	
Radioactive Sources		**Target Materials**			photographic developers	
	Permanent Installation		Beryllium (Be)		PolyChlorinatedBiphenyls	
	Temporary Use		Lithium (Li)		Scintillation Oil	
Type:			Mercury (Hg)		TEA	
Strength:			Lead (Pb)		TMAE	
Lasers			Tungsten (W)		Other: Activated Water?	
	Permanent installation		Uranium (U)			
	Temporary installation		Other:	**Nuclear Materials**		
	Calibration	**Electrical Equipment**		Name:		
	Alignment		Cryo/Electrical devices	Weight:		
Type:			Capacitor Banks	**Mechanical Structures**		
Wattage:			High Voltage (50V)		Lifting Devices	
MFR Class:			Exposed Equipment over 50 V		Motion Controllers	
			Non-commercial/Non-PREP		Scaffolding/ Elevated Platforms	
			Modified Commercial/PREP		Other:	
Vacuum Vessels		**Pressure Vessels**		**Cryogenics**		
Inside Diameter:		Inside Diameter:			Beam line magnets	
Operating Pressure:		Operating Pressure:			Analysis magnets	
Window Material:		Window Material:			Target	
Window Thickness:		Window Thickness:			Bubble chamber	

OTHER GAS EMISSION

Greenhouse Gasses (Need to be tracked and reported to DOE)

- ❑ Carbon Dioxide, including CO_2 mixes such as Ar/CO_2
- ❑ Methane
- ❑ Nitrous Oxide
- ❑ Sulfur Hexafluoride
- ❑ Hydro fluorocarbons
- ❑ Per fluorocarbons
- ❑ Nitrogen Trifluoride

NUCLEAR MATERIALS

Reportable Elements and Isotopes / Weight Units / Rounding

Name of Material	MT Code	Reporting Weight Unit Report to Nearest Whole Unit	Element Weight	Isotope Weight	Isotope Weight %
Depleted Uranium	10	Whole Kg	Total U	U-235	U-235
Enriched Uranium	20	Whole Gm	Total U	U-235	U-235
Plutonium-242[1]	40	Whole Gm	Total Pu	Pu-242	Pu-242
Americium-241[2]	44	Whole Gm	Total Am	Am-241	–
Americium-243[2]	45	Whole Gm	Total Am	Am-243	–
Curium	46	Whole Gm	Total Cm	Cm-246	–
Californium	48	Whole Microgram	–	Cf-252	–
Plutonium	50	Whole Gm	Total Pu	Pu-239+Pu-241	Pu-240
Enriched Lithium	60	Whole Kg	Total Li	Li-6	Li-6
Uranium-233	70	Whole Gm	Total U	U-233	U-232 (ppm)
Normal Uranium	81	Whole Kg	Total U	–	–
Neptunium-237	82	Whole Gm	Total Np	–	–
Plutonium-238[3]	83	Gm to tenth	Total Pu	Pu-238	Pu-238
Deuterium[4]	86	Kg to tenth	D_2O	D_2	
Tritium[5]	87	Gm to hundredth	Total H-3	–	–
Thorium	88	Whole Kg	Total Th	–	–
Uranium in Cascades[6]	89	Whole Gm	Total U	U-235	U-235

[1] Report as Pu-242 if the contained Pu-242 is 20 percent or greater of total plutonium by weight; otherwise, report as Pu 239-241.

[2] Americium and Neptunium-237 contained in plutonium as part of the natural in-growth process are not required to be accounted for or reported until separated from the plutonium.

[3] Report as Pu-238 if the contained Pu-238 is 10 percent or greater of total plutonium by weight; otherwise, report as plutonium Pu 239-241.

[4] For deuterium in the form of heavy water, both the element and isotope weight fields should be used; otherwise, report isotope weight only.

[5] Tritium contained in water (H2O or D2O) used as a moderator in a nuclear reactor is not an accountable material.

[6] Uranium in cascades is treated as enriched uranium and should be reported as material type 89.